reducing the normal stock or wood capital and representing, as it were, the interest. We may, for instance, come to the conclusion that on our 30,000-acre tract an annual felling budget of two to three million feet, B. M., of logs and eight to ten thousand cords of wood may be indicated, for which we must secure a market. It may also be found that the working capital of wood, an accumulation of capital and interest for centuries as found in the virgin forest, is unnecessarily large, beyond the normal, and hence should, for good business reasons, be as quickly reduced as it can be done profitably, or else if we have to deal with cutover lands we may have to reduce our annual cut, saving gradually enough to first establish the desirable working capital.

Finally, when all these bases for operation are ascertained we may formulate the working plans and decide not only on the quantities to be cut, the operations of improvement required, the manner of conducting the whole management, but also determine in what portions of the property the principal activity is to be exercised during the first ten or twenty years, leaving it to the future manager to modify the plans as experience and changes of condition indicate.

That a well-planned bookkeeping is necessary if we would want to know how our business progresses is self-understood. Not only is it necessary to keep those accounts of financial transactions which any business requires, but each compartment in the forest must be kept account of, with a separate ledger account to show what material it has furnished, what stock remains in it, what operations it has required and whatever position in the general scheme it takes.

A demonstration and experimental area, as the proposed school forest is to be, will, to be sure, entail many operations which in a mere business forest might be dispensed with or delayed to more opportune time. Hence its financial results on the whole may not satisfy the financier. No such experiment, it may be asserted, can be made to demonstrate the profitableness of a business; it can only serve to show methods and their results and to furnish the basis and elements for profit calculations. Nevertheless it is expected that the experiment will pay for itself, while furnishing the desirable object lessons both to the students and timberland owners, the citizens of the State of New York, owners of the great State Park, included.

When this experiment is established, and has demonstrated that rational forest management is possible in this country as well as in the older countries, the constitutional bar will undoubtedly be removed and the entire State holdings placed under proper technical administration, with the students from the State College of Forestry its managers.

B. E. FERNOW.

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GEOLOGY AND GEOGRAPHY AT THE AMERICAN ASSOCIATION MEETING.

II.

14. *Another Episode in the History of Niagara River.* By J. W. SPENCER, Washington, D. C. This paper is a sequel to one read before the American Association four years ago, on the duration of Niagara Falls. It announces the discovery that while the falls were receding from Foster's flats to the locality of the railway bridges the fall of the river reached its maximum of 420 feet by the retreat of the Ontario waters to the north. The return to the present amount of 326 feet was interrupted by the rising of the level of the lake in the gorge to a height of 75 feet above its present level, thus reducing the actual fall of the river to 250 feet. The evidence of this is preserved in the remains of a terrace deposit opposite the foot of Foster's flats and

a corresponding terrace just outside the mouth of the gorge; and these terraces, with other parts of the shore line in the Ontario basin which marks the rise of the waters so as to flood the Niagara gorge, are here named the Niagara strand. The rising of the waters was occasioned by the lifting of the barrier at the outlet of Lake Ontario to an elevation 100 feet higher than now. By the subsequent erosion of this barrier, which was partly composed of drift, the actual fall of the Niagara waters has been increased to its present figure. The reduction of the descent of the river is found to be sufficient to account for the shallowness of the channel at the Whirlpool rapids. The narrowing of this section is explained by the fact that the youthful Niagara took possession of a small preglacial valley there, giving greater depth to the river. It is further probable that the volume of the river was less at that time, since it is supposed that a portion of the outflow of the Great Lakes then passed to the Mississippi.

15. *The Age of Niagara Falls as Indicated by the Erosion at the Mouth of the Gorge.* By Professor G. Frederick Wright, Oberlin, Ohio. The late Dr. James Hall early noted the significant fact that "the outlet of the chasm below Niagara Falls is scarcely wider than elsewhere along its course." Clearly this is important evidence of the late date of its origin, and it has been used by the author and others in support of the short estimates which have been made concerning the length of time separating us from the Glacial period. A close examination made by the author this summer greatly strengthens the force of the argument, since he found that the disintegrating forces tending to enlarge the outlet and give it a V-shape are more rapid than has been supposed. The depth of the gorge at the outlet, from the top of the Niagara limestone to the river, is 340 feet. The thickness of that formation of limestone at the surface is here, however, only about 40 feet; while the soft Niagara shales underlying it are from 60 to 75 feet thick. Below there is a stratum of Clinton limestone 30 feet in thickness, and below that a shaly deposit of 70 feet. The Niagara shales at this point have never been covered by talus, so that they have always been accessible to disintegration by atmospheric agencies.

Somewhat over forty years ago a railroad was built along the face of the eastern side of the gorge, affording an opportunity to observe the rate of disintegration. All along where a perpendicular exposure was made, the shale has crumbled away to an extent of several feet, and in some places to that of 20 feet. A conservative estimate of the rate of disintegration for the 70 feet of Niagara shales supporting the Niagara limestone would be one inch a year, with a probable rate of two inches a year. But at the lowest estimate no more than 12,000 years would be required for the enlargement of the upper part of the mouth of the gorge 1,000 feet on each side, which is very largely in excess of the actual amount of enlargement. Some of the recent estimates, therefore, which would make the gorge from 30,000 to 40,000 years old, are evidently extravagant, and must incorporate some error in their premises. The age of the gorge cannot be much more than 10-000 years, and is probably considerably less.

16. *A Recently Discovered Cave of Celestite Crystals at Put-in-Bay, Ohio.* By Professor G. Frederick Wright. The principal locality in America from which museums have been supplied with specimens of celestite (sulphate of strontium) is Strontian Island, two or three miles from Put-in-Bay Island, in the western end of lake Erie. Just as this supply was becoming exhausted, a remarkable fissure was discovered last winter on Put-in-Bay Island, which is completely surrounded with very large crystals

of this beautiful mineral. The fissure was penetrated in digging a well seventeen feet below the surface, and is large enough to permit the entrance of ten or twelve people at a time. It is not an ordinary cavern, but apparently is the interior of an immense 'geode' lined with celestite crystals. The geological formation in which it occurs is the Waterlime of the Lower Helderberg. Large deposits of gypsum occur in the vicinity.

17. *Geography and Resources of the Siberian Island of Sakhalin.* By PROFESSOR BENJAMIN HOWARD, London, England. Sakhalin has a length of about 670 miles and a breadth of 20 to 150 miles. The features which the author observed during his visits to this island in 1890 and 1896, as here described, are (1) the absence of natural harbors and reliable anchorages around its entire 1,500 miles of coast, and the reasons for it; (2) the contrast which this island, having no volcanoes, exhibits as compared with the volcanic chain of the whole Japanese group and its continuation in the volcanoes of Kamtchatka; (3) the contradiction which Sakhalin, possessing an almost subarctic climate, affords to the popular belief that latitude is the dominant factor in the determination of climates; (4) its mineral resources, especially coal and iron; (5) the immensity and density of the fish shoals in the neighboring waters; (6) the absence of navigable rivers; (7) the persistence of unadulterated life and manners in the aboriginal Ainos there as when described nearly three thousand years ago by the oldest Japanese historian; (8) the vast numbers of medusæ (jelly-fish) along the southern coast, and the marvelous phosphorescence of the sea as witnessed by the author; (9) the strategic value of the island to Russia; (10) the completeness of its adaptation to its present use as a penal stronghold; (11) the present development of its agricultural and mineral resources, and its prospective self-maintenance chiefly from its future fishing industries; and (12) the expediency of maintaining the spelling of the name Sakhalin, as here used.

18. *Evidence of Recent Great Elevation of New England.* By J. W. SPENCER, Washington, D. C. This paper was a description of the valley terraces in mountainous parts of New England, illustrated by sections showing that the declivities of the valleys are not by even slopes, but by a succession of steps, the plains of which become terraces farther down the valley. These steps are regarded as gradation plains in the changes of the baselevel of erosion, and many of the corresponding terraces are hundreds of feet above the floors of the valleys. From these features it is inferred that the recent rise of the mountainous region can be approximately measured by the sum of the heights of the steps. Yet it is not inferred that the elevation need to have been from below the sea level; and consequently the gravels are not claimed to have been necessarily of marine origin.

19. *The Oldest Palæozoic Fauna.* By G. F. MATTHEW, St. John, N. B. This fauna is contained in a series of beds unconformably underlying the Cambrian system in eastern Canada and Newfoundland. The base of the Cambrian in the former country is marked by a barren sandstone, and in the latter by conglomerates. Erosion of the lower terrane continued up to and included the time of the Paradoxides fauna. The relation of these two terranes is comparable to that of the Upper and Lower Silurian in New York, or the Carboniferous and Subcarboniferous in eastern Canada. The fauna known consists of about twenty species. It contains no trilobites either in eastern Canada or Newfoundland. Various forms of the family Hyolithidæ are the dominant types. Other gastropods allied to Capulus and Platyceras occur; also brachiopods; remains of echinoderms (cys-

tids?); and corals allied to Archæocyathus and Dictyocyathus. The thin limestones which occur in the upper half of the terrane are supposed to have originated chiefly from foraminifera (Globigerina, etc.).

20. *The Oldest Known Rock.* By Professor N. H. Winchell, Minneapolis, Minn. With a brief description of the other members of the Archean series as made out by the Geological Survey of Minnesota, this paper more particularly described the so-called greenstones of this State, which the author considers the bottom of the Archean scale and the representative of the original crust of the earth formed from the molten mass by the earliest consolidation. The greenstones are divisible into two parts, one igneous and the other clastic, the latter succeeding the former with a confused and apparently sometimes non-conformable superposition, somewhat as surface eruptive rocks might be superposed, in the presence of oceanic action, upon a massive of the same nature at the same place. The clastic portions of the greenstones vary to more silicious rocks, constituting great thicknesses of graywackes, phyllites and conglomerates; and as such they have been converted by widespread metamorphism into mica schists and gneisses, the alteration coming on by degrees, increasing in intensity toward centers of granitic intrusion and toward the great areas of granite and igneous gneiss.

Such granite and such metamorphic rocks, as a whole, have been considered the basement rock, the oldest known rocks of the country. But, following up the long known fact that the Laurentian granite and igneous gneisses cut the schists and sedimentary gneisses and hence are younger, they are thus shown to be younger also than the bottom greenstones. They occasionally penetrate these greenstones and change them to amphibolyte and pyroxene gneiss. These metamorphic schists and gneisses seem to be a representative of the sedimentary portion of the Lower Laurentian of Canada, while the igneous granite and gneisses are as plainly a general parallel of the igneous portion of that series. It follows, therefore, that the Canadian Laurentian is, as a whole, of later date than the greenstones, if the succession is the same as in the Northwest, and that the greenstones should be considered the bottom rock of the geological scale.

21. *The Origin of the Archean Igneous Rocks.* By N. H. Winchell. The greenstones, which were discussed in the preceding paper, are supposed to represent the primeval crust of the earth. The author denies the possibility of the derivation of the alkaline magma from these ferro-magnesian rocks by any of the methods of lixiviation or of differentiation which are currently proposed by geologists who have lately discussed the origin of the igneous rocks. Accepting this ferro-magnesian crust as the rock of the first magma of the earth, the author shows that it could not give rise to minerals consisting largely of a potash base, such as orthoclase and microcline, which constitute the greatest distinguishing element in the alkaline magma. Neither could it give rise to the preponderating percentage of silica which accompanies the potash minerals. These characters, therefore, must have some other source. The potash is believed to have existed in the ocean itself which immediately followed the consolidation of the first crust. Such an alkaline ocean, especially if heated, would hold in solution much silica. Hence followed the precipitation of alkaline silicates, and of excess of silica; hence, also, the alkaline character of the schists and gneisses when its sediments were formed into rock and metamorphosed; and hence, when fused, the alkaline magma. As to the cause of this potassic ocean by which the great stock of the world's potash was

stored in the Archean rocks, the author does not attempt any explanation, further than to suggest that possibly, owing to the chemical characteristics of potassium, it remained in the earth's atmosphere until the consolidation and also the cooling of the first crust sufficiently to allow the ocean to rest upon it, and that it was then rapidly extracted by the moist, heavy atmosphere that prevailed, being carried into the sea.

22. *Joints in Rocks.* By PROFESSOR C. R. VAN HISE, Madison, Wis. (Read by title.)

23. *Notes on Some European Museums.* By DR. E. O. HOVEY, American Museum of Natural History, New York City. Relating to museum administration and methods of display, as observed in Europe; published in the *American Naturalist.*

24. *History of the Blue Hills Complex.* By PROFESSOR W. O. CROSBY, Boston, Mass. Relating to the tract of the Blue Hills, on the southern border of the Boston basin. (Read by title.)

25. *Paleontology of the Cambrian Terranes of the Boston Basin.* By AMADEUS W. GRABAU, Boston, Mass. The Lower Cambrian rocks are found to contain fossils at Nahant, Mill Cove, Rowley, Topsfield and Jeffreys Ledge. The last three localities were discovered by Mr. J. H. Sears, who was also the first discoverer of fossils at Nahant (1887). From collections made by him at Nahant seven species have been identified, including four of Hyolithes. The fossils detected in the rocks of the other localities consist of indeterminate sections of Hyolithes and a cross section of a trilobite from Mill Cove. From pebbles and boulders found at Nahant and Cohasset by Mr. T. A. Watson, a large number of Lower Cambrian fossils have been obtained, representing fifteen species. The Middle Cambrian of Hayward's Creek, South Braintree, contains the large *Paradoxides harlani, Agraulus quadrangularis* and several other forms. The Upper Cambrian is represented in this district only by erratics containing *Lingula* and *Scolithus.*

26. *Diamonds in Meteorites.* By MRS. E. M. SOUVIELLE, Jacksonville, Fla.

27. *The Periodic Variations of Glaciers.* By PROFESSOR HARRY F. REID, Baltimore, Md. (Read by title.) The *Journal of Geology* for July-August (Vol. VI., pp. 473–476) contains an article by Professor Reid on this subject, giving records for Europe, Asia and Greenland in 1896 and for the United States in 1897. A general retreat of the glaciers is noted, excepting slight tendency to advance in Greenland.

28. *Notes on the Occurrence of Tourmalines in California.* By C. R. ORCUTT, San Diego, Cal. Near San Diego an enormous bed or vein of lepidolite (lithia mica), 60 feet or more in width where best exposed, contains rubellite (pink tourmaline) in large amounts. As a source of lithia and potash this deposit must soon take first rank commercially. It is now being worked as an open quarry, and 1,500,000 tons are estimated to be available. Much of the rubellite has been distributed to museums. Tourmalines of gem quality were first found during the present year, being all of the red variety. Black tourmalines are frequent, but green tourmalines occur only sparingly, at this locality.

29. *The Agassiz Geological Explorations in the West Indies.* By ROBERT T. HILL, Washington, D. C. This paper, which, with several preceding, was presented in Cambridge on Friday forenoon in the Museum of Comparative Zoology (largely founded through the labors and munificence of Louis Agassiz and his son, Professor Alexander Agassiz), described briefly the expeditions made during recent years by Alexander Agassiz, with his assistants, for observations in zoology and geology, on sea and land, in the West Indies and on the Isthmus of Panama. Within Late Tertiary and Quaternary time many parts of this region have undergone

great epeirogenic movements, perhaps more interesting than those of any other part of the world in such late geologic periods.

Dr. J. F. Whiteaves, Paleontologist of the Canadian Geological Survey, Ottawa, Canada, was elected to be the Vice-President for Section E, and Professor Arthur Hollick, of Columbia University, New York City, to be its Secretary, in the Association meeting at Columbus, Ohio, next year. Geology is also represented in the election of Professor Edward Orton, of Columbus, to be the President of that meeting.

Warren Upham,
Secretary of Section E, 1898.

NOTES ON INORGANIC CHEMISTRY.

The presidential address of Sir William Crookes before the British Association at Bristol this year was concerned with two themes. The first of these was the world's wheat supply and how it can be increased. Not only is Great Britain unable to raise her own wheat supply, but the wheat-producing area of the world is being so rapidly taken up that by 1931 the world will be unable to raise enough for consumption, and the immediate prospect will be a wheat famine. This can be obviated only by increasing the wheat crop per acre, that is by using fertilizers to a much greater extent than is at present the case. The chief fertilizer needed is combined nitrogen. The Chili saltpeter now extensively used is brought from northern Chili, but if used on all wheat land, the supply from the Chili mines would be exhausted in a very few years. Cultures of bacteria which assimilate atmospheric nitrogen have been tried as a fertilizer, but thus far with little success. The great desideratum is a process for the manufacture of sodium nitrate directly from the nitrogen of the air. With an indefinite supply of fertilizer the world's wheat yield can be doubled with little increase of acreage. This would tide matters over till the latter part of the twentieth century, when it may be hoped that the luxuriant vegetable growth of the tropics will be utilized for food supply. At all events, the wheat famine would be postponed till the present generation has disappeared from active work. It may not prove impossible to solve the problem of 'fixing' atmospheric nitrogen even at the present time. In 1892 Professor Crookes exhibited at a Soirée of the Royal Society an experiment on the 'Flame of Burning Nitrogen.' Nitrogen will burn in oxygen if the heat of the ignition point can be maintained. This can be done by the electric current, and it is calculated, that by utilizing the energy of Niagara for electricity, sodium nitrate can be manufactured at a cost of not over $25 per ton—less than its present price. This figure would probably be reduced were the operations carried on on a large scale. The amount of nitrate needed for fertilizing the whole possible wheat acreage of the world would be twelve millions of tons annually; Niagara could furnish the electrical energy for the manufacture of this without sensibly diminishing its flow.

The second part of Professor Crookes' address was devoted to recent developments in chemistry and electricity. Dewar's liquefaction of hydrogen and the consequent low temperature work; Ramsay's discoveries of krypton, neon and metargon; Nasini's discovery of coronium in the volcanic gases at Pozzuoli; Marconi's application of Hertz's discovery to telegraphy without wires; Zeeman's phenomenon and the possible light it may throw on the ether; the theory of the Röntgen rays and their nature; a possible theory for the Becquerel rays emitted from uranium and its compounds, and the allied rays from thorium, and Curie's newly discovered polonium—these were all considered, and then the announcement made of a new